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Diagnostic Methods for Temporomandibular Disorders: What We Have Learned in Two Decades*

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Correct diagnosis is the basis for proper treatment. It is unfortunate, therefore, that despite basic and clinical research performed in the past 20 years, little progress has been made in improving our ability to correctly diagnose temporomandibular disorders (TMD). To a large extent this relates to the continued confusion regarding which conditions should appropriately be classified under the collective heading of TMD.

To understand how this confusion has occurred, it is necessary to look back to the year 1934 when an otolaryngologist named James Costen described a series of signs and symptoms, including preauricular pain, that ultimately came to bear the name Costen's syndrome.[1] This paper was to have a profound effect on thinking in the field for the next 40 years.

Prior to Costen's paper there was a disease concept of temporomandibular joint disorders, and most publications on the subject were concerned with such conditions as arthritis, dislocation, subluxation, or ankylosis. Subsequent to that time, however, there developed a symptom concept of temporomandibular joint dysfunction and publications began to speak of a syndrome rather than about specific pathologic entities. In the subsequent 20 years, the name of the syndrome changed,[2–4] and it was ultimately shown that many of the signs and symptoms described by Costen were not related to involvement of the temporomandibular joint, and that most of his anatomic explanations were incorrect.[5] However, both clinicians and researchers still continued to make the same mistake—they clustered together under one diagnostic heading a variety of etiologically unrelated conditions merely because they produced similar signs and symptoms. As a result, even up to the present time, many investigations of temporomandibular joint pain and dysfunction are based on a heterogenous population of patients and therefore the findings have limited clinical applicability.

The attempt to resolve this issue by using the term temporomandibular disorder (TMD) rather than temporomandibular joint disorder (TMJ) has only served to confuse the issue further[6], because it tends to combine under one diagnostic heading those conditions that involve the temporomandibular joint (TMJ problems) with a condition that primarily involves the muscles of mastication [myofascial pain-dysfunction (MPD) syndrome]. Not only are these conditions anatomically unrelated, but also they are unrelated etiologically. One consists of a cluster of organic diseases, only a few of which are generally associated with pain—and the other is a psychophysiologic disorder.[7] Just because some patients with MPD syndrome can ultimately develop degenerative joint disease, or vice versa, is no reason to include them in the same diagnostic classification. Until an appropriate separation is made between TMJ diseases and MPD syndrome both clinically and in the selection of patients for research studies, investigators and clinicians will continue to have problems interpreting and applying the results.

Even though pain is the most frequent symptom of the common pathologic conditions involving the temporomandibular joint and also of MPD syndrome, it is evident from the literature that the diagnostic procedures used in the past, as well as those used in the present, deal essentially with attempts to determine the pathophysiologic basis of the pain rather than with detection of the pain itself. In this regard, the focus has been mainly on the recognition of the dysfunction associated with painful joints, anatomic derangements, and muscle fatigue and spasm. Those studies related to the pain itself have been mainly attempts to determine its quality and measure its intensity.

Although obtaining a thorough history and doing a careful physical examination are probably still the best methods of detecting the various signs and symptoms and establishing a diagnosis, the similarity of the clinical findings in patients with various forms of temporomandibular joint disease and those with MPD syndrome have led to a continued search for more objective technological

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methods to help improve the diagnostic capabilities of the clinician. The history of this search is one characterized by confusion, misinterpretation, and clinical abuse.

Obviously, any technological assessment that would provide valid, reliable, and meaningful objective information would be a welcome addition for both the researcher and the clinician. On the other hand, the use of unproven technology that has the potential for providing unreliable, invalid, or otherwise incorrect findings could lead to serious errors in diagnosis and subsequently to the improper selection of treatment. Even more seriously, healthy people might be considered to have a subclinical "problem" if certain findings on technological assessment during routine examination were incorrectly interpreted as "pathologic." It is the purpose of this article, therefore, to discuss those diagnostic procedures that have been developed during the past two decades and, on the basis of the available scientific and clinical evidence, arrive at some conclusions regarding those which may be clinically beneficial and those which appear to be unreliable or ineffective.

METHODS USED TO STUDY JAW AND MUSCLE FUNCTION

Among the earliest devices that were recommended for the diagnosis of temporomandibular disorders were dental articulators and their associated pantographic tracing devices.[8] The use of these instruments for diagnostic purposes was based on the assumption that such disorders were due to derangements in jaw and occlusal relationships and that these instruments could accurately record and replicate human jaw positions and movements. Such analyses became the basis for occlusally related treatments such as bite-opening, equilibration, and complete dental rehabilitation.[9,10] Although numerous studies have since shown that there are few direct and consistent relationships between occlusal dysharmonies and TMD,[11–13] many of these treatments continue to be used. The technological basis for the diagnosis of tooth and jaw abnormalities, however, has become more sophisticated with the development of complex electronic tracking and recording devices.

Electromyography,[14–17] kinesiographic tracking systems,[18,19] and cineradiography[20,21] have been used either singly or in combination to provide quantitative data about mandibular activity. Mandibular function has also been studied with machines designed to dynamically duplicate the simultaneous chewing movements of the subject.[18] Although all of these devices are helpful research tools that have provided useful information leading to a better understanding of jaw function and dysfunction, they have been of little use on a clinical basis. The major problem with such technology has been that the studies performed with these instruments have shown repeatedly that the normal range of human jaw and masticatory muscle function varies widely from one individual to another. Thus, whereas group means may show statistically significant differences on one or more parameters, the broad range of individual findings often results in considerable overlap between the "abnormal" and normal groups and, therefore, it becomes difficult to draw diagnostic conclusions in any specific patient. The great risk in basing a diagnosis on machine-generated data without a precise definition of normality is that it can easily lead to unnecessary as well as inappropriate therapy.

The use of sophisticated sound recording machines to study TMJ noises that occur during mandibular movement, and the presumed relationship of these noises to intraarticular pathology, also have been described.[22–23] Originally, this approach was intended simply to characterize various normal and abnormal TMJ sounds.[24–25] However, with the development of digitized sonography and complex analyses of sound-wave patterns, some clinicians have attempted to use this approach for the differential diagnosis of TMJ disc displacements and joint pathology. Because of the lack of distinct differences between the various sound patterns and the inability to reliably correlate the patterns with clinical symptoms of individual patients, sonography has not become a reliable technological modality for the diagnosis of TMJ pathology.[26]

DIAGNOSTIC IMAGING TECHNIQUES

As the major components of the temporomandibular joint are bony, it is logical that the use of radiographs has played a major role in the diagnosis of disorders of this joint. The location of the joint immediately under the base of the skull, however, makes it very difficult to obtain a clear view of the articulating structures in a single projection. Probably the most popular technique to visualize the TMJ used over the years has been the transcranial view, which angles the x-ray beam in a vertical direction and thereby allows the images of the two joints to be separated from one another. Headholders have been devised to standardize head position with this procedure and permit sequential films to be compared. Part of the reason for the popularity of the transcranial technique is that it can be used in the office with the standard dental x-ray machine.

There are several problems, however, with the use of transcranial radiography. First, it does not provide a view of the entire condyle; only the lateral pole is clearly visualized.[27] As a result, it is extremely difficult to see early pathologic changes in the articular surface, and even gross changes can be easily missed. The second problem is that the radiograph does not provide a true image of the joint

space because, being only a two-dimensional view, it shows the largest part of the condyle opposite the narrowest part of the fossa. Ordinarily, this would not be a problem, because there is no great diagnostic significance to the width of the joint space or to the concentricity of the condyle in the fossa. However, it has become a significant factor because whole schemes of jaw repositioning and occlusal reconstruction have been based on erroneous interpretations of joint space and condylar position from transcranial radiographs.[28,29]

Another radiologic technique is the use of serial tracings of cephalometric radiographs taken in the open, rest, and closed jaw positions to study condylar movement.[30] Under normal circumstances it is not possible to see the condyles clearly in a cephalometric radiograph because of superimposition in the lateral projection. However, it is possible to trace the rest of the mandible and to extrapolate condylar movement from its movement. Based on such tracings, it was shown that the condyle moved upward and backward from rest position to full closure in patients with temporomandibular disorders rather than upward and forward as it does in normal subjects. It was therefore suggested that there was compression of the retrodiscal tissue in TMD patients and that this caused their problem. Although the observations on the changes in condylar position were correct, the interpretation of the findings was wrong. It was subsequently shown that the ear posts of the cephalostat used to take such radiographs produced sufficient discomfort in TMD patients to cause them to hold the jaw forward in the rest position and that this led to a posterior movement when they were asked to bite in full occlusion for the final radiograph.[31]

Although some useful information about pathologic bony changes can be obtained from routine radiographs of the TMJ, these changes usually have to be quite extensive to be seen. When pathology is suspected and not visible, or when more detail is desired about visible changes, tomography provides the clearest image and the most complete visualization.[32,33] Hypocycloidal tomography is preferable to linear tomography, and in either case correction of head position to compensate for the horizontal and vertical condylar angles gives the most accurate and undistorted image.[34,35] Computed tomography (CT) can also provide an excellent image of the condyle and fossa and is particularly helpful in visualizing the regions adjacent to the joint.[36] However, the added exposure to radiation and the greater cost limit the use of the CT scan to such special cases.

Although the usual radiologic techniques may show bony changes in the TMJ, it is sometimes necessary to determine if such pathologic alterations are active or if what is seen represents a static process. Moreover, very early pathologic changes may not be detectable with routine radiographs. In such instances scintigraphy can provide a more dynamic picture of what is occurring.[37,38] However, it is a rather gross technique and, although it may quantitate the degree of activity, it does not provide a clear indication of the anatomical extent of the problem.[27] Therefore, its use needs to be combined with more qualitative radiographic techniques such as standard or computed tomography.

Because the intraarticular disc is not visible in routine radiographs, the recognition of pathology in this structure was not possible until the introduction of TMJ arthrography. Although TMJ arthrography is not a new procedure[39], it was originally viewed as having only limited diagnostic value clinically, with its main benefit being a research tool.[39,40] This view, plus the fact that the anatomical overlap of the lower joint space by the convex upper joint space prevented accurate visualization of the disc in the transcranial projection when both spaces were simultaneously filled with radiopaque fluid, led to abandonment of the procedure until 1965 when arthrotomography was introduced.[41] For the first time, this technique provided a relatively precise means of radiographically evaluating the soft tissue components of the TMJ. As a result, a better understanding of disc-condyle relationships in normal and abnormal states was developed, and this has led to improved methods for both the nonsurgical and surgical management of internal derangements of the TMJ.

Arthrography, however, is an invasive procedure associated with some morbidity. It is often difficult to accomplish in patients with suspected nonreducing anterior displacement of the disc, a situation where it would provide the most useful information.[42] It also produces a distorted image because the joint spaces are artificially distended. For these reasons, as well as the fact that the mechanisms of clicking and locking are now well understood, the routine use of arthrography in all patients with disc derangements is no longer justified. The diagnosis can usually be made clinically, particularly when clicking is present, and radiographic confirmation provides little additional information that would alter the ultimate therapeutic approach. Moreover, magnetic resonance imaging (MRI) now provides an excellent noninvasive technique for viewing the disc without producing distortion and without exposing the patient to radiation.[43]

DIAGNOSTIC APPLIANCES

Intraoral acrylic appliances (biteplate, splint, night guard, orthotic, mandibular orthopedic repositioning appliance, etc.) have been used in one form or another for over 40 years.[8] Although used mainly for therapeutic purposes, they have also been used by some clinicians as a diagnostic tool. Originally, when mandibular overclosure was con-

sidered to be a common etiologic factor in TMD, appliances with a raised acrylic platform were used to reestablish a new vertical dimension on the assumption that if opening the bite cured the patient it was a priori evidence for the accuracy of the diagnosis. Subsequently, when the concept of occlusal interferences as a cause of TMD came into vogue, the fact that the appliance eliminated the direct contact of the teeth was also used as the basis for considering it to be diagnostic as well as therapeutic. Clinicians went so far as to call these biteplates "autorepositioning" appliances on the assumption that when the mandible was freed of occlusal interferences it would seek its optimal neuromuscular position.[44]

There are many fallacies with the idea of using treatment outcome of any sort either to confirm a diagnosis or to support an etiologic concept.[45,46] There is also the danger, as in the case of bite appliances, of using such an approach to legitimize an inappropriate form of therapy. Just because a bite appliance eliminates the patient's symptoms is no reason for using this as the basis for performing secondary, irreversible bite-changing procedures. Unfortunately, it has taken many years to convince practitioners that reversible appliance therapy usually can be used successfully without the need for secondarily changing the occlusion.[47,48]

DIAGNOSTIC ARTHROSCOPY

A recent technological development in the diagnosis of intraarticular disorders of the temporomandibular joint has been the miniaturized arthroscope. This instrument, which is inserted through a small stab incision or skin puncture, permits observation of the structures bounding the upper joint space (glenoid fossa, articular eminence, and superior aspect of the disc and retrodiscal tissue).[49] Alterations in the synovial membranes and in the fibrous and fibrocartilagenous linings of the articular structures can be noted and biopsied, if necessary. In this manner, diagnostic arthroscopy provides useful information regarding subtle, yet significant, changes within the joint, which cannot be detected by other diagnostic methods and which can have important implications in determining the correct therapy. The usefulness of diagnostic arthroscopy will increase even more as our understanding of the significance of the changes observed improves and we become more knowledgeable about the efficacy of specific therapeutic interventions.

DISCUSSION

It is not uncommon for those who advocate new technological approaches to the diagnosis of clinical disorders to meet some resistance from their colleagues. The question that always arises in such circumstances is whether the opponents are truly responsible skeptics, or merely uninformed, antiprogressives. In the past two decades the field of temporomandibular disorders has been filled with charges and countercharges, which unfortunately have clouded the real issue: what technological developments are, in fact, clinically valuable at this time? The answer to this question depends to some extent on a proper understanding of what temporomandibular disorders really are, because this understanding should form the basis for seeking appropriate and useful diagnostic procedures. Until the tendency to group a variety of etiologically unrelated conditions under a single diagnostic heading such as TMJ syndrome or craniomandibular disorder is discontinued, there will continue to be frustration in any attempt to develop new diagnostic technologies.[7]

A valid contemporary characterization of temporomandibular disorders is to describe them as a series of orthopedic diseases and/or dysfunctions.[42] This means that they fall into a category of problems that can generally be identified from the history and clinical findings, and that they usually do not require either invasive or noninvasive diagnostic technologies to be detected. Likewise, temporomandibular disorders do not generally have the morbidity of the more serious medical conditions, and so the urgency for early or subclinical detection is reduced accordingly. Thus, we can afford to be conservative in our approach to the acceptance of new diagnostic procedures.

There are currently only a few diagnostic techniques that can be used reliably in clinical situations. Although the concepts and goals underlying the development of some procedures may have been reasonable (e.g., the detection and classification of masticatory muscle dysfunction using electromyography), a critical evaluation of the positive and negative reports in the literature reveals that most of the proposed technological devices have failed to meet the proper standards as valid diagnostic tools. The only proven technologies for the diagnosis of TMD patients at this point seem to be: 1) hard-tissue radiographs and soft-tissue imaging techniques that show, within their limitations, the integrity and relationships of anatomic structures in the temporomandibular joint; and 2) arthroscopy for direct examination of the joint. All of the other instruments can only be considered as research tools at the present time, or are devices that provide information that has no great clinical significance.

The confusing nature of craniofacial pain makes all clinicians wish to see more advances in the diagnosis of these complex conditions. If we accept the fundamental definition that diagnosis is "determining what physiologic dysfunction or pathologic process is occurring, and in which tissue," then we must supplement our clinical skills with appropriate technological modalities in order to be-

come more accurate diagnosticians. At the same time, however, we must continue to maintain a healthy skepticism about developments that purport to make our life easier until such time as they meet the rigid criteria for accuracy and validity that ensure their safe and effective use.

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